



INTERNAL WORKING DOCUMENT

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PLANTATION TENDING TRIALS

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ABSTRACT

Time trials with a two man crew were conducted to assess the feasibility of removing competition from softwood plantations with land-held auto-manual brush saws and "whipper" machines using experienced woods workers. The saws and "whippers" were used in combination and separately. Brush saws, or whipper saws working independently were the most productive with an average cost of 48.81 and 52.90 per acre, respectively. The "whipper" and brush saw working in combination with an average cost of \$92.26 per acre were also considered feasible. It is expected that this method of competition control would be feasible on at least 15,000 acres (35%) of the area requiring treatment in New Brunswick each year. Further trials are required on a broader range of plantation conditions to determine productivity during the summer months when seedlings are difficult to locate. The auto-manual method requires workers with some experience and the cost figures obtained are only valid for work that is carried out in May, October and November or when the planted seedlings are visible.

INTRODUCTION

As an alternative to herbicide application for weed control in softwood plantations the New Brunswick Department of Natural Resources initiated an auto-manual cleaning trial for a two week period in October 1982. Initially the trial was set up to determine the practicality of using "whippers" to remove competition from softwood plantations as an alternative to herbicide use. Because of problems encountered in removing woody stemmed competition with these "whippers" the trial was expanded to test the productivity that could be achieved with brush saws. Time trials were conducted to compare the productivity of four inter-related cleaning systems. Two types of cleaning machines were employed; whippers, manufactured by HMC, Torrance Co., and thinning saws, produced by Husqvarna.

The test areas selected were in Region 4, Brown's Mountain and Dinnen Woods near Canterbury and Anderson Road near McGivney. These sites were recommended for herbicide application but did not meet the two mile exclusion limits imposed by the Department of Environment regulations. Each site offered characteristics that were typical of other problem plantations.

Site Description

The Brown's Mountain site was scarified in 1980 with a C & H plow then planted with bare root white spruce in 1981. The plantation had regenerated with heavy raspberry, ferns, fireweed and abundant sugar maple, ash, hazelnut and pin cherry (Table 1). The combined hardwood competition had a density of 25,300 stems/ha with an average height of 1.23 metres. There were 122,000 raspberry stems/ha with an average height of 0.80 metres. Most of the competition was located on the mounds created by the C & H plow. The average height of the planted white spruce was 20 centimetres. Evidence of rabbit browse was extensive but locating the seedlings was not a problem.

The Anderson Road plantation had been harvested in 1973, scarified in 1977 with a disc trencher and planted in 1978 with black spruce paper pots. Regeneration primarily consisted of pin cherry and raspberry with some white birch, poplar, red maple and balsam fir (Table 2). The combined hardwood competition had a density of 24,000 stems/ha with an average height of 1.54 metres. There were 158,000 raspberry stems/ha with an average height of 0.64 metres. The competition was evenly distributed. The average height of the black spruce seedlings was 61 cm, locating them was not a problem.

The Dinnen Woods had been site prepared in 1980 with a C & H plow and planted in 1981 with black spruce paper pots. The area had regenerated with heavy raspberry, hazelnut, red

maple and pin cherry. Some sugar maple, white birch, balsam fir and ferns were also present (Table 3). The combined hardwood competition had a density of 20,600 stems/ha with an average height of 1.10 metres. There were 149,000 raspberry stems/ha with an average height of 0.92 metres. Most of the competing vegetation was located on the mounds created by the C & H plow. The average height of the planted black spruce was 14 centimetres. Evidence of rabbit browse was extensive, in many cases the trees were very difficult to locate.

To evaluate the sites a number of 1/2500 ha (1/1000 ac) plots were randomly established in each trial. A stem count was conducted by species, the results of which are listed in Tables, Pages 7, 8 and 9.

Procedure

Time studies were conducted for the following systems:

1. Thinning saw preceeding whipper with monofilament.
2. Thinning saws working alone.
3. Whipper saw (a circular saw which replaced the monofilament head on the whipper) preceeding whipper with monofilament.
4. Whipper saws working alone.

An independent whipper with monofilament, was tested in a preliminary study. This study showed that the whipper by itself was only effective in cutting grasses, ferns and medium density raspberry. The woody stems greater than 4 millimeters prevalent on all three sites were of

sufficient stocking to prevent cleaning around individual trees. Further reference to this system is included in the recommendation.

The operators were timed for the actual working time involved in each trial, breaks to eat, smoke, gas-up or sharpen blades was not included. Downtime caused by machine failure was not included but is noted in the summary of the system concerned. The operators were instructed to clean a 2-3 feet radius around each planted tree and to cut any overhanging competition.

Systems 1 and 3 consisted of two operators working in the same row. A saw went first to eliminate woody species and heavy raspberry, while the whipper with monofilament followed to clean out grass, ferns and light raspberry. The monofilament has the capability to clean to ground level and tended to throw all debris out of the immediate area around the planted tree. Systems 1 and 3 were not utilized at Anderson Road due to the larger size of the hardwood (to 3" diam) and the lack of concentration of raspberry. These systems were used at Brown's Mountain and Dinnen Woods which were younger plantations with most herbaceous and hardwood competition located on the mounds left by the C & H plow.

For systems 2 and 4 each operator used a saw and worked along a separate row cleaning out all forms of competition around the planted tree. Systems 2 and 4 were applicable to all test areas.

TABLE 1. BROWN'S MOUNTAIN REGENERATION SUMMARY

DENSITY OF COMPETITION WITHIN PLANTATIONS WHERE SYSTEM TESTS WERE CARRIED OUT (stems/ha)

Species	System 1	System 2	System 3	System 4	Average Height (m)
Raspberry	189,000	136,000	72,500	92,500	0.80
Sugar Maple	4,380	5,620	10,600	27,500	1.33
Ash	0	620	3,750	13,100	1.06
Striped Maple	3,120	1,250	0	2,500	1.17
Pin Cherry	0	4,380	0	620	1.76
Poplar	0	620	0	0	0.70
Other Hardwoods	15,620	3,120	620	0	1.03
Beech	0	620	0	620	1.20
Balsam Fir	0	1,250	620	0	0.60
Black Spruce	0	0	620	0	0.35
All woody stems	23,100/ha	17,500/ha	16,200/ha	44,300/ha	1.23

Average Density	25,300 stems/ha	Average Density	122,000 stems/ha
Woody stems	10,200 stems/ac	Raspberry	49,400 stems/ac
Average Density	2,400 stems/ha		
Planted W. Spruce	970 stems/ac		

TABLE 2. ANDERSON ROAD REGENERATION SUMMARY

Species	DENSITY OF COMPETITION (stems/ha)				Average Height (m)
	System 2	System 4	System 2	System 4	
Raspberry	96,900	170,000	241,000	125,000	0.64
Pin Cherry	25,600	15,000	20,600	6,880	1.56
White Birch	4,380	3,380	1,250	3,120	1.48
Poplar	0	2,500	620	0	2.40
Red Maple	620	0	0	620	0.70
Other Hardwoods	0	0	0	3,120	0.74
Balsam Fir	0	3,120	620	3,750	0.65
All woody stems	30,600/ha	25,000/ha	23,100/ha	17,500/ha	1.54

Average Density	24,000 stems/ha	Average Density	158,000 stems/ha
Woody stems	9,710 stems/ac	Raspberry	63,900 stems/ac
Average Density	2,050 stems/ha		
Planted B. Spruce	830 stems/ac		

TABLE 3. DINNEN WOODS REGENERATION SUMMARY

DENSITY OF COMPETITION (stems/ha)

Species	System 1	System 3	System 1	System 2	Average Height (m)
Raspberry	212,000	90,600	141,000	152,000	0.92
Pin Cherry	5,620	6,880	2,500	2,500	1.21
White Birch	0	620	0	0	1.60
Sugar Maple	0	0	6,250	1,880	1.14
Red Maple	8,120	620	5,000	9,380	1.13
Other Hardwoods	5,000	4,380	0	29,400	1.01
Balsam Fir	1,880	0	0	2,500	0.28
All woody stems	20,600/ha	12,500/ha	13,800/ha	45,700/ha	1.10
Average Density	23,200 stems/ha		Average Density	149,000 stems/ha	
Woody stems	9,390 stems/ac		Raspberry	60,300 stems/ha	
Average Density	2,200 stems/ha				
Planted B. Spruce	890 stems/ac				

RESULTS

Time Trials

See Appendix I for results of time trials with a two man crew.

The cleaning rates for each system are given in Table 4, Page 12.

Cost Analysis

In order to provide a meaningful cost analysis the time trial data presented in this report was projected to a hypothetical operation based on a six (6) man crew. (See Table 4, Page 12). To account for travel time and breaks taken during the day an actual working time of six (6) hours per day was employed. Machine depreciation was based on a life-time service of 1000 hours per machine (McKay, R. 1982 pers. comm.). A half hour per day per crew was allowed for machine failure..

Cost Projection

Van rental (\$25.00/day + \$0.18/km)	\$ 43.00/day
*Vehicle fuel (12 mi/gal)	\$ 11.76/day
Foreman wages + technician (1/2 time)	\$100.00/day
(12% fringe benefits)	\$ 12.00/day
Operator wages (labor rate \$7.90/hr X 6)	\$379.20/day
(12% fringe benefits)	\$ 45.50/day

Machine Cost:

System 1: 3 whippers @ \$550.

3 thinning saws @ \$900

$\frac{\$4350}{1000 \text{ hrs}} = \$4.35/\text{hr} \times 6 \text{ hr/day} \quad \$26.10/\text{day}$

System 2: 6 thinning saws @ \$900

$\frac{\$5400}{1000} = \$5.40/\text{hr} \times 6 \text{ hr/day} \quad \$ 32.40/\text{day}$

System 3 and 4:

6 "Green Machines" ** @ \$550

$\frac{\$3300}{1000} = \$3.30/\text{hr} \times 6 \text{ hr/day} \quad \$ 19.80/\text{day}$

Machine Fuel and Oil

System 1: 3 whippers fuel \$3.30/day

oil 1.50/day

3 thinning saws

fuel 7.00/day

oil 3.20/day \$ 15.00/day

System 2: 6 thinning saws \$ 20.40/day

** Systems 3 and 4:

6 whippers \$ 9.60/day

Maintenance Costs @ \$3.00/day/machine \$ 18.00/day

*Based on 100 km round trip to site.

** Brand name for whipper saw used.

** There is no difference in fuel consumption for the whipper with saw blade or monofilament.

Total Cost of 6 man crew per day:

System 1: 650.56 per crew per day

System 2: 662.26 per crew per day

System 3 and 4: 638.86 per crew per day

Projected productivity and costs are given in Tables 4 & 5,
Pages 12 and 13.

TABLE 4.

SYSTEM COMPARISON BY SITE

Test Area	Productivity Rate Per Man			Density Hdwd stems/ha
	System 1	System 2	System 3	System 4
Brown's Mountain	0.07 ha/hr (0.17 ac/hr)	0.16 ha/hr (0.40 ac/hr)	0.06 ha/hr (0.15 ac/hr)	0.13 ha/hr (0.32 ac/hr)
Anderson Road	N.A.	0.13 ha/hr (0.32 ac/hr)	N.A.	0.15 ha/hr (0.37 ac/hr)
Dinnen Woods	0.10 ha/hr (0.25 ac/hr)	0.17 ha/hr (0.42 ac/hr)	0.10 ha/hr (0.25 ac/hr)	N.A.

System 1. Thinning saw preceeding whipper monofilament

2. Independent thinning saws

3. Whipper saw preceeding whipper monofilament

4. Independent whipper saws

TABLE 5.

PROJECTED CLEANING COSTS BASED ON A 6 MAN CREW

	System 1	System 2	System 3	System 4
Brown's Mountain	\$ 265.98/ha 107.68/ac	\$ 113.77/ha 46.04/ac	\$ 286.91/ha 116.17/ac	\$ 139.41/ha 56.44/ac
Anderson Road		\$ 138.46/ha 56.06/ac		\$ 121.92/ha 49.36/ac
Dinnen Woods	\$ 177.39/ha 71.82/ac	\$ 109.41/ha 44.30/ac	\$ 181.32/ha 73.40/ac	
Average Costs	\$ 221.69/ha 89.75/ac	\$ 120.55/ha 48.81/ac	\$ 234.12/ha 94.78/ac	\$ 130.67/ha 52.90/ac

System 1: Thinning saw proceeding whipper monofilament

2: Independent thinning saws

3: Whipper saw proceeding whipper monofilament

4: Independent whipper saw

DISCUSSION

Brown's Mountain

The low productivity rates for systems 1 and 3, at Brown's Mountain when compared to those at Dinnen Woods, can be attributed to the operator's lack of experience handling the whipper with monofilament cord rather than to a higher density of hardwood competition. The difference in densities at Brown's Mountain (25,300 stems/ha) and Dinnen Woods (23,200 stems/ha) is insignificant. Inexperience with the whipper monofilament also resulted in the inadvertant pruning of a number of planted seedlings.

The decrease in the productivity rates from 0.16 ha/hr (system 2) to 0.13 ha/hr (system 4) can be accounted for by an increase in competition density. Table 1 indicates a substantial increase in the density of woody stems from 17,500/ha (system 2) to 44,300/ha (system 4).

Anderson Road

The higher productivity rate for system 4 over system 2 can be attributed to less competition (Table 2) Also when using the whipper saws (system 4) operators tended to by-pass heavier competition. This was necessary because the saw blades would seize when cutting stems greater than two inches in diameter. This problem did not exist with the thinning saws which were designed to cut heavier material.

Dinnen Woods

A major problem at this site was locating the

planted black spruce. This had a direct influence on the productivity rates. The spruce averaged 14 cm in height but many were considerably smaller (less than 5 cm) due to intense rabbit browse. In several instances the foreman was required to aid in seedling location.

Operational Problems

A substantial amount of time was required to locate small seedlings even though the time trials were conducted when competing vegetation was dead and brown. Production can be expected to drop considerably when seedlings are obscured by green vegetation.

Rocks were encountered on all test sites limiting how close to ground level a saw could cut. Concealed rocks invariably meant dull blades and decreased production. Rocks and heavy slash increased the amount of monofilament cord used.

In heavy hardwood competition and slash it was easier for the operator with a thinning saw to clear everything in his path rather than pick his way around planted trees. On occasion the saw was used to locate unseen seedlings under heavy vegetation. This resulted in the pruning of some seedlings.

Operational problems due to the type of machine being used centered exclusively around the whippers and are listed below. These problems were encountered with the most rugged type of whipper now available. Modification to the design of the whipper drive shaft and head might eliminate

some of these problems.

1. Poor quality blades: one tooth for every four inches caused the blade to seize when cutting stems greater than two inches in diameter.
2. Small drive shaft: does not appear rugged enough to handle thick stems and could probably be bent with excessive force.
3. Blades or whipper head with monofilament are mounted on a sharp angle with respect to the driveshaft. This makes it difficult to cut vegetation on uphill slopes such as the mounds created by a C & H plow.
4. Swivel handles are difficult to control when cutting thick stems and can possibly be bent with excessive force.
5. Blade guards are large and awkward to maneuver through thick vegetation.
6. Bolts and screws loosen and strip easily, especially those associated with blade guards and clamps on the engine.
7. Monofilament cord is quickly used up in heavy slash and rocks, it has difficulty cleaning out heavy raspberry and is suited primarily for grass and ferns.

During the time trials for systems 1 and 3 (saws

preceeding the whipper with monofilament) when it became apparent that the monofilament cord could not contend with heavy raspberry or even grass mixed with slash, it was necessary to make the saw responsible for most of the removal. The whipper with monofilament was relegated to simply cleaning away a few stems missed by the saw or those already cut. However, where competition was light and of small diameter the whipper could clean to bare ground whereas the saws often left a 4 - 12" "stubble".

Recommendations

Whippers with monofilament are not suitable for heavy raspberry or woody stems over 4 mm. In these conditions the head must be advanced slowly and there is excessive wear and breakage of the monofilament. Solid wire and multistrand wire were tried in place of the monofilament but they did not increase the cutting ability and the wire would break where it entered the head after a couple of minutes use. An engineering agency such as FERRIC will be approached re: designing a more rugged whipper and cord.

Systems 1 and 3, saws preceeding whipper monofilament, consistently produce much slower productivity rates when compared to systems 2 and/or 4, independent saws (Table 4 & Appendix I). The feasibility of cleaning the same areas twice (systems 1 and 3) should be questioned as should the necessity to clean to bare ground. More trials are required especially concerning the latter.

Another consideration to deal with is the timing

of future operations. Is fall cleaning worthwhile after all competing vegetation is dead? Also, it can be expected that locating seedling will be a major problem during late spring and summer cleaning projects. (A similar trial conducted in 1981 during mid summer resulted in costs 3 - 5 times greater than those generated in this study). It is recommended that further trials be considered for comparing results already accumulated.

Future trials should be conducted to determine the "regrowth" response to this type of competition removal.

Considering the average cost of using thinning saws (\$50.43/ac) and the average cost of using saws combined with whippers (\$92.26/ac) it is evident that these methods are possible alternatives to herbicide use (average \$35.00/ac). Even with the necessity of determining the "regrowth effect" (suckering, new shoots, etc.) it is apparent that the manual method would be acceptable on areas untreatable due to environmental restrictions. This could amount to 10,000 acres in N. B. annually. It is not difficult to estimate another 5,000 acres annually which has competition characteristics comparable with these manual cleaning methods. Experienced workers, especially when using brush saws, will also be a requirement.

APPENDIX I

RESULTS FROM TIME TRIALS

WITH A TWO MAN CREW

APPENDIX IA

Brown's Mountain

Tues (am) Thinning saw preceeding whipper monofilament
(System 1):

Total area cleaned	0.35 ha	(.86 ac)
Total time	3.08 hr	
Cleaning rate per man	0.06 ha/hr	(0.14 ac/hr)
Downtime	0.00 hr	

Tues (pm) Independent thinning saws (System 2):

Total area cleaned	0.71 ha	(1.75 ac)
Total time	2.08 hr	
Cleaning rate per man	0.17 ha/hr	(0.42 ac/hr)
Downtime	0.00 hr	

Wed (am & pm) Whipper saws preceeding whipper mono-
filament (System 3):

Total area cleaned	0.70 ha	(1.73 ac)
Total time	5.58 hr	
Cleaning rate per man	0.06 ha/hr	(0.15 ac/hr)
Downtime	0.00 hr	

Thurs (am) Independent whipper saws (System 4):

Total area cleaned	0.71 ha	(1.75 ac)
Total time	2.92 hr	
Cleaning rate per man	0.12 ha/hr	(0.30 ac/hr)
Downtime	0.00 hr	

Thurs (pm) Thinning saw preceeding whipper monofilament
(System 1):

Total area cleaned	0.35 ha	(0.86 ac)
Total time	2.00 hr	
Cleaning rate per man	0.09 ha/hr	(0.22 ac/hr)
Downtime	0.00 hr	

Fri (am) Independent thinning saws (System 2):

Total area cleaned	0.71 ha	(1.75 ac)
Total time	2.25 hr	
Cleaning rate per man	0.16 ha/hr	(0.39 ac/hr)
Downtime	0.00 hr	

Fri (pm) Independent whipper saws (System 4):

Total area cleaned	0.71 ha	(1.75 ac)
Total time	2.58 hr	
Cleaning rate per man	0.14 ha/hr	(0.34 ac/hr)
Downtime	0.00 hr	

APPENDIX IB

Anderson Road

Tues (am) Independent thinning saws (System 2):

Total area cleaned	0.49 ha	(1.22 ac)
Total time	2.17 hr	
Cleaning rate per man	0.11 ha/hr	(0.28 ac/hr)
Downtime	0.00 hr	

Tues (pm) Independent whipper saws (System 4):

Total area cleaned	0.70 ha	(1.73 ac)
Total time	2.75 hr	
Cleaning rate per man	0.13 ha/hr	(0.31 ac/hr)
Downtime	0.17 hr	
Cleaning rate (including downtime)	0.12 ha/hr	(0.30 ac/hr)

Wed (am) Independent thinning saws (System 2):

Total area cleaned	0.79 ha	(1.95 ac)
Total time	2.58 hr	
Cleaning rate per man	0.15 ha/hr	(0.38 ac/hr)
Downtime	0.00 hr	

Wed (pm) Independent whipper saws (System 4):

Total area cleaned	0.90 ha	(2.22 ac)
Total time	2.67 hr	
Cleaning rate per man	0.17 ha/hr	(0.42 ac/hr)
Downtime	0.00 hr	

APPENDIX IC

Dinnen Woods

Thurs (am) Thinning saw preceeding whipper monofilament
(System 1):

Total area cleaned	0.48 ha	(1.19 ac)
Total time	2.01 hr	
Cleaning rate per man	0.12 ha/hr	(0.30 ac/hr)
Downtime	0.00 hr	

Thurs (pm) Whipper saw preceeding whipper monofilament
(System 3):

Total area cleaned	0.53 ha	(1.31 ac)
Total time	2.67 hr	
Cleaning rate per man	0.10 ha/hr	(0.25 ac/hr)
Downtime	0.00 hr	

Fri (am) Thinning saw preceeding whipper monofilament
(System 1):

Total area cleaned	0.52 ha	(1.29 ac)
Total time	2.83 hr	
Cleaning rate per man	0.09 ha/hr	(0.23 ac/hr)
Downtime	0.00 hr	

Fri (pm) Independent thinning saws (System 2):

Total area cleaned	0.74 ha	(1.84 ac)
Total time	2.17 hr	
Cleaning rate per man	0.17 ha/hr	(0.42 ac/hr)
Downtime	0.00 hr	